EP-22

GPO PRICE $ .15

CFSTI PRICE(S) $ _____

Hard copy (HC) _____

Microfiche (MF) .50

ff 653 July 65

FACILITY FORM 602

N65-29050
(ACCESSION NUMBER)

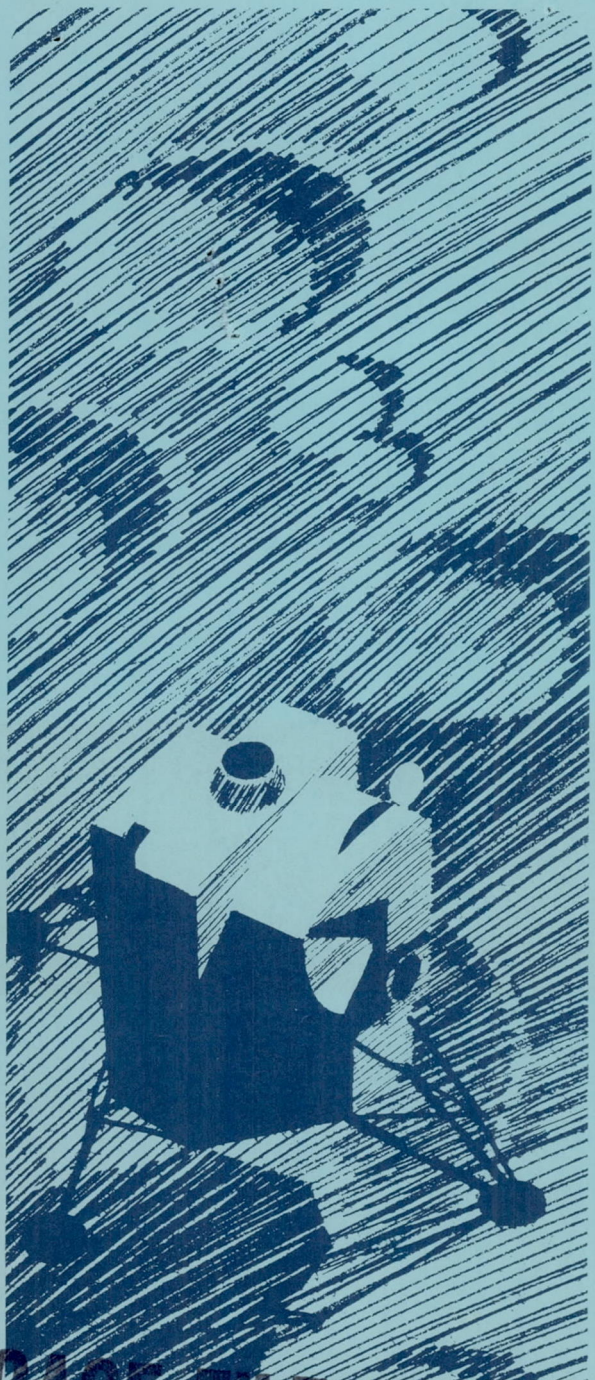
18
(PAGES)

(NASA CR OR TMX OR AD NUMBER)

(THRU)

1
(CODE)

30
(CATEGORY)



Project Apollo's LEM

nasa's mission

"Aeronautical and space science and technology and the application thereof to the conduct of peaceful activities within and outside the atmosphere. . ."

The quotation, from the National Aeronautics and Space Act of 1958, describes the areas of NASA's mission.

What are the goals and objectives?

NASA's program activity for the remainder of this decade will increase our scientific knowledge of the universe, will advance our space technology, and will support the application of this endeavor to operational systems.

In science, interests center on the properties of the earth, on earth-sun relationships, on the moon, on the space environment, on the physical nature of the universe and on the possibilities of life in space.

In technology, NASA is concerned with providing knowledge pertinent to spacecraft and launch vehicles, aircraft, propulsion, space power, human factors and electronics. Exploration will concentrate on the moon and the planets. In the applications area, work continues in support of meteorology and communications systems; NASA will assist in the development of V/STOL (vertical and short take off and landing aircraft), and other aircraft, including the supersonic transport.

The U.S. aeronautics and space program has been NASA's mission since 1958. The National Aeronautics and Space Act of 1958 became law on July 29 of that year, stating, as U.S. policy that "activities in space should be devoted to peaceful purposes for the benefit of all mankind." The National Aeronautics and Space Administration was organized and declared ready to function on October 1.

Immediately transferred to NASA were the personnel of the National Advisory Committee for Aeronautics (NACA), and its five laboratories, which became NASA field facilities: Langley Research Center at Hampton, Va.; Ames Research Center, Moffett Field, Calif.; Lewis Research Center, Cleveland, Ohio; the Flight Research Center, Edwards, Calif.; and Wallops Station, Wallops Island, Va.

Also transferred to NASA were various space activities from the Department of Defense, including the Naval Research Laboratory's Project Vanguard; the Jet Propulsion Laboratory (JPL) managed by the California Institute of Technology (Army contractor for rocket and space missions); and the George C. Marshall Space Flight Center (Operations

Man in Space

Division of the Army Ballistic Missile Agency) at Huntsville, Ala.

The Goddard Space Flight Center was organized and located in new quarters at Greenbelt, Md. A NASA Launch Operations Center was established at Cape Canaveral—its name was later changed to John F. Kennedy Space Center at Cape Kennedy. The Manned Spacecraft Center—first organized as the Space Task Group for Project Mercury at Langley—was established at Houston, Texas. Later, an Electronics Research Center was established in Cambridge, Mass.

While these organizations and reorganizations were being accomplished, NASA's program was carried forward.

manned space flight

PROJECT MERCURY—In Project Mercury, six manned space flights were accomplished as planned, while the whole world watched and shared both the tense moments and the triumphant recoveries at sea of the astronauts.

Alan B. Shepard, Jr., was the first U.S. astronaut to be rocketed into space, in a 15-minute flight on May 5, 1961. A second sub-orbital space flight was accomplished on July 21, 1961, by Virgil I. Grissom. On February 20, 1962, John H. Glenn, Jr., became the first American to orbit the earth—completing three circuits in five hours. M. Scott Carpenter flew three orbits on May 24, 1962, Walter M. Shirra, Jr., flew 6 on October 3, 1962 and L. Gordon Cooper, Jr., completed the flight phase of Project Mercury with a 22-orbit, 34-hour earth-orbiting space flight on May 15 and 16, 1963.

Project Mercury not only put the first Americans into space but laid a sound foundation for the technology of future manned space flight. It demonstrated the effects of space on man and proved that man could increase the reliability of spacecraft controls.

PROJECT GEMINI—The second step of NASA's manned space effort is Project Gemini, using a two-man spacecraft system to conduct long-duration, earth-orbital flights and to develop new techniques. Gemini's program includes orbital rendezvous, docking (joining) two spacecraft, maneuvering the joined spacecraft as a unit, astronaut activity outside of an orbiting spacecraft, and a series of scientific experiments.

In Gemini's planned rendezvous procedure an Atlas launch vehicle places a fully fueled Agena vehicle into a circular orbit, and a Titan

Orbiting Geophysical Observatory (OGO)

launch vehicle sends Gemini into an elliptical orbit which intersects the path of Agena. As the astronauts near Agena, they reduce the difference in speed between the two craft to about 1½ miles per hour. They steer Gemini so that its nose touches the matching slot of Agena. Coupling is automatic. The astronauts can then use Agena's propulsion system as well as Gemini's for further orbital maneuvers.

PROJECT APOLLO—Apollo, designed to land American explorers on the moon and bring them back safely, will have a three-part spacecraft: The Command Module is the operational and living area for three astronauts. The Service Module houses the rocket engines and fuel supplies which will enable the astronauts to propel their craft into and out of lunar orbit and to change their course in space. The Lunar Excursion Module (LEM) will separate from the others for the lunar landing. LEM will have rockets for slowing the landing on the moon, launching from the moon and maneuvering in lunar orbit.

The journey to the moon will begin when a three-stage Saturn V vehicle launches Apollo and the Saturn V third stage into earth orbit. At the proper moment, the third stage will refire to put the spacecraft into a lunar trajectory. When reaching the moon's vicinity, Apollo will be directed into a circular orbit about 100 miles above the moon. Two of the astronauts will enter the LEM, detach it and land on the moon while the third crewman will continue to orbit the moon in the Command Module.

The two astronauts will take turns exploring the moon's surface near their landing site, collect samples and conduct scientific experiments. Then they will board LEM, launch it to rendezvous with the parent craft, enter the Command Module and jettison LEM.

Firing a rocket in the Service Module will boost the Command and Service Modules out of lunar orbit toward the earth. The Service Module will be jettisoned just before re-entry into the earth's atmosphere. Three parachutes will slow down the Command Module for landing.

aeronautical research

NASA conducts aeronautical research to develop and define new knowledge and capabilities of aircraft.

Best known example of NASA aeronautics work is the X-15 airplane, a flying laboratory

Mariner IV

which carries out space and aeronautics research in the air and nearby space. Conceived by NACA in 1954, the X-15 was built as a joint project of the Air Force, Navy and NACA and operated under NASA management at Flight Research Center.

Launched at 45,000 feet from a B-52 aircraft, the X-15's 57,000-pound thrust rocket engine operates for less than two minutes; the aircraft then soars upward on a long ballistic flight and glides to land on a dry lake bed within ten to thirteen minutes. In the thin upper atmosphere, the pilot controls the X-15 by small jets in the wings and nose. The X-15 pioneered the control system used in the Mercury and Gemini spacecraft.

Three X-15 aircraft made more than 130 flights in less than six years, set two official world altitude records, exceeded 354,000 feet altitude and speed of 4,100 miles per hour, and amassed a large amount of flight experience at supersonic and hypersonic speeds.

NASA research with the supersonic commercial transport, originated in 1956, is continuing in all phases of aerodynamics, propulsion, structures and materials, and operational factors such as the sonic boom (explosive sound transmitted to the ground).

V/STOL stands for Vertical and Short Takeoff and Landing, and the research program in this area seeks means of providing improved capability for aircraft to rise and descend vertically or with short takeoff and landing runs.

Aeronautical studies are carried out in flight research and wind tunnels, simulators and other ground facilities in cooperation with other agencies, including industry, universities, the Departmnt of Defense, and the Federal Aviation Agency.

unmanned satellites and sounding rockets

The unmanned scientific satellites gather data while in orbit around the earth. Sounding rockets explore the upper atmosphere (they do not orbit).

Scientific satellites have made it possible for scientists to recognize the existence of the Van Allen Radiation Region in the space around the earth, to learn that the earth is very slightly "pear-shaped," to find that sunlight exerts pressure, and to study the effects of tiny bits of matter in space (micrometeoroids), among other scientific investigations.

Other satellites are used as orbiting solar, astronomical and geophysical observatories.

Syncom

Biosatellites are being developed to carry into space a variety of plants and animals to determine the effects of weightlessness and radiation on living things.

unmanned lunar and interplanetary spacecraft

Exploration of the moon and planets has begun with unmanned, instrumented spacecraft.

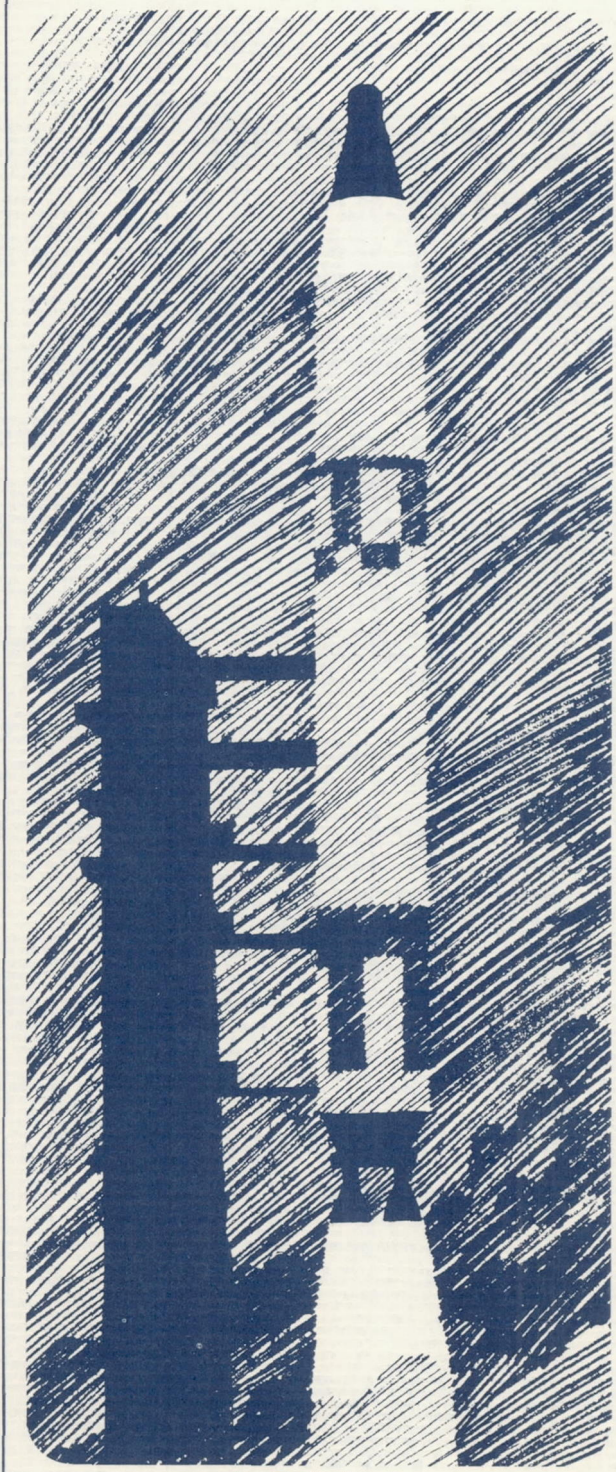
PIONEER is a series of long distance space probes to investigate interplanetary environment and to monitor solar radiation and interplanetary magnetic fields as far away as 50 million miles.

RANGER spacecraft have gathered data about the moon and tested space technology required for future lunar and interplanetary missions. Ranger IV, launched April 23, 1962, was the first U.S. spacecraft to land on the moon. Later Rangers obtained television pictures which distinguish features as small as three feet across on the lunar surface. Ranger VII, on July 31, 1964, transmitted more than 4,000 photographs of the moon's surface. Ranger VIII, on February 20, 1965, sent more than 7,000, covering another area. Ranger IX, on March 24, 1965, returned another 5,000 pictures of a crater area, some of which were viewed on home television as they were radioed back to earth.

SURVEYOR will make "soft landings" on the moon, as contrasted with the crashing impacts of Ranger. It will decelerate from a lunar approach velocity of 9,000 feet per second to a touchdown speed of less than 15 feet per second. Having landed, Surveyor will take pictures and make measurements to check suitability of sites for manned landings. It will also aid in the design of protective shielding for spacecraft and astronaut spacesuits.

LUNAR ORBITER spacecraft will be sent into orbit around the moon to obtain photographs of the surface which will help in the selection of landing sites. Lunar Orbiter also will obtain information about the moon's characteristics and gravitational pull.

MARINER spacecraft have the mission of flying to the vicinity of Venus and Mars to gather scientific information. Mariner II flew past Venus at a distance of 21,648 miles on December 14, 1962 and transmitted information of great significance to astronomers.



Gemini-Titan Launch

Mariner IV was launched towards Mars on November 28, 1964 on a path, to fly past the red planet on July 14, 1965.

application satellites

Practical satellite systems are being developed to aid in everyday weather forecasting and global communication.

COMMUNICATIONS SATELLITES—The first communications satellite, ECHO I, orbited in 1960, proved that communication between distant areas is possible by bouncing radio signals off a passive satellite from one point on earth to another. Echo II was put into orbit in January, 1964.

Project RELAY was undertaken to test intercontinental transmission of telephone, television, teleprint and facsimile radio signals from medium altitude (about 1,000 to 5,000 miles in the case of Relay: medium altitude could be up to about 12,000 miles). It is an active repeater satellite, i.e., it receives, amplifies and retransmits signals.

SYNCOM, an experimental global communications system, employs active repeater satellites which travel around the world in the same time it takes the earth to rotate around its axis, hence, have no motion east or west relative to the earth's surface. "Synchronous altitude" is 22,300 miles; at this height three Syncoms can provide global coverage.

TELSTAR, similar to Relay in purpose, differs in important structural and technical features. These differences afford comparisons for development of operational equipment. Telstar was developed by the American Telephone & Telegraph Co. and launched by NASA.

The Communications Satellite Corporation (Comsat), equally owned by communications companies and the public, has been established for operation of a world-wide commercial communications satellite system. The corporation has entered into an agreement with NASA to launch its satellites, and to provide related support services; the first Comsat satellite, "Early Bird," was launched April 7, 1965.

METEOROLOGICAL SATELLITES—TIROS satellites have television cameras to take cloud pictures and infrared sensors to measure heat radiated from the earth. (TIROS is an acronym for Television and Infrared Observation Satellite). These meteorological satellites have been used for day-to-day weather observation and for tracking hurricanes.

Saturn I

Early models of TIROS orbited the earth from west to east and had attitudes which were fixed in space—they could take pictures only part of the time, when the flat base, and hence the cameras, pointed towards the ground. TIROS IX, launched into a polar orbit in January of 1965 "rolls" through its orbit like a cartwheel; two cameras take pictures of the earth's surface from the rim of the wheel, as each camera in turn points towards the earth. This arrangement permits pictures of the entire earth to be taken daily.

NIMBUS is an advanced, experimental weather satellite with improved equipment both for picture taking and for observations of the earth's heat radiation with infrared sensors. The first Nimbus was launched in August, 1964.

The letters TOS stand for TIROS Operational Satellites, planned as working satellites based upon the TIROS and Nimbus experiments.

launch vehicles

A launch vehicle propels and guides a spacecraft into space, providing the rocket power (thrust) which carries the spacecraft into orbit around the earth, or accelerates it to escape velocity so it can overcome the earth's gravitational field and move out into deep space.

U.S. launch vehicles have been developed so that the right type will be available for each specialized job. These rockets vary in many respects. They range in size from the slender Scout to the huge Saturn V. They vary in the amount of weight they can place at specified distances, and in the types of engines, fuels and number of operating stages.

SCOUT is a relatively inexpensive four-stage vehicle for launching small satellites and high altitude probes. A solid-propellant carrier, Scout can be launched from many sites. It can place a 240-pound satellite into a 300-mile orbit.

DELTA has completed a long list of missions with meteorological, communications and scientific satellites. One of the most reliable U.S. launch vehicles, Delta has about three times the payload capacity of Scout. It was Delta which successfully launched Echo, Relay, Telstar, Syncom, TIROS, a number of the Explorers, OSO, and Ariel.

THOR-AGENA is a two-stage vehicle that can send 1,600 pounds into earth orbit of 300 miles or 600 pounds into a 1,200-mile orbit.

Lift-off

It has launched such spacecraft as Echo II, Alouette and Nimbus.

ATLAS-AGENA is a two-stage vehicle which has launched Ranger, Mariner and the Orbiting Geophysical Observatory.

CENTAUR was this country's first launch vehicle to use liquid hydrogen fuel which provides great thrust with less weight. It has been launched as the second stage of an Atlas-Centaur combination, with a "mass-model" of the Surveyor spacecraft.

The TITAN launch vehicle for Project Gemini, is an adaptation of the military Titan II. It uses a liquid propellant that can be stored in its fuel tank indefinitely. Unlike other liquid propellants, this fuel need not be drained if a flight is postponed.

Three SATURN launch vehicles are in development for the progressive phases of the Apollo project. They are Saturn I, for launches of engineering and test models of Apollo; Saturn IB which is designed to launch the complete Apollo Command, Service and LEM modules into earth orbit; and Saturn V which is the launch vehicle for manned lunar flight. (The Saturns also will be assigned to other space programs).

Saturn V is the most powerful launch vehicle under development by the United States. Its first stage will consist of five engines generating a total thrust of 7.5 million pounds. Upper stages will have 200,000-pound-thrust rocket engines fueled by liquid hydrogen and liquid oxygen. Five of these will make up the second stage of Saturn V, one the third. Saturn V will have the capability of launching a 45-ton spacecraft to the moon, 30 tons to Mars or Venus, or 120 tons into orbit around the earth.

tracking and data acquisition

To monitor spacecraft in space, receive the data they send back, and issue "commands" to the spacecraft to control their maneuvers and activities, NASA maintains three worldwide tracking and data acquisition networks. STADAN (for Space Tracking and Data Acquisition Network) services scientific, communications and meteorological satellites. DSN (for Deep Space Network) tracks and communicates with lunar and interplanetary spacecraft such as Ranger and Mariner. The Manned Space Flight Network tracks and communicates with manned spacecraft.

international activities

Cooperative arrangements are maintained with more than 60 other countries in a variety of space exploration projects. Included are the tracking networks (above), cooperative satellite projects, flights in NASA spacecraft of experiments prepared by foreign scientists, sounding rocket projects, and personnel exchanges.

scope of the space effort

NASA conducts a program of research on a wide front of tasks ranging from basic studies of matter to advanced hardware systems for current aeronautical and space missions, and for future missions which appear to hold promise of results. Many thousands of such tasks are carried out, largely through the five NASA Research Centers, and these in turn conduct and manage projects by contract with industry and universities, as well as in their own laboratories and flight tests.

The NASA system of management has efficiently mobilized for research and development in aeronautics and space some 400,000 men and women and is utilizing some 20,000 industrial companies under prime and subcontract arrangements.

New processes and techniques developed in the space program have already stimulated new industrial methods and products. For example, techniques devised to make spacecraft instruments light in weight and small in size are used to produce other compact and streamlined equipment. Development of new and better computers is spurred by space research. And these are merely representative of many collateral results of the space program.

GPO : 1965 OF—773-693

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 – Price 15 cents

opment of spacecraft for unmanned lunar and planetary exploration (Ranger, Mariner, Surveyor) and the operation of a world-wide deep space tracking and control network. There is a broad-scale program of supporting research.

JOHN F. KENNEDY SPACE CENTER, FLA.

Manned and unmanned spacecraft are launched at the John F. Kennedy Space Center on Cape Kennedy. Formerly known as the Launch Operations Center at Cape Canaveral, "The Cape" is the site from which the astronauts of Projects Mercury and Gemini were rocketed into space. Facilities are under construction at the Merritt Island Launch Area for launching the huge Saturn V. Functions of the Kennedy Space Center include complete planning, designing, development and utilization of launching facilities.

LANGLEY RESEARCH CENTER, HAMPTON, VA.

Oldest of the NASA Centers, Langley has the task of providing technology for manned and unmanned exploration of space and for improvement and extension of performance and utility of aircraft. The major technical areas of Langley are theoretical and experimental dynamics of flight through the entire speed range, flight mechanics, materials and structures, space mechanics, instrumentation, solid rocket technology, and advanced ramjet engine research. The Center conceives, develops and operates simulators for the supersonic transport and lunar landing and the Gemini project, and conducts an extensive program of V/STOL flight research projects.

LEWIS RESEARCH CENTER, CLEVELAND, OHIO

The mission of this Center is propulsion and space power generation. Fields of investigation are materials and metallurgy, problems concerned with the use of extremely high and low temperature materials, combustion and direct energy conversion, chemical, nuclear and electric rocket propulsion systems, advanced turbojet power plants, fuels and lubricants, plasmas and magneto-hydrodynamics. Lewis has technical management of a number of chemical, solid and liquid rocket projects including the Agena and Centaur.

Plum Brook Station at Sandusky, Ohio, with facilities for propulsion research and development, is operated as an arm of Lewis.

MANNED SPACECRAFT CENTER, HOUSTON, TEX.

The Manned Spacecraft Center is a new NASA facility located 20 miles southeast of Houston, Tex. on the edge of Clear Lake. It has the responsibility for the design, development, and testing of manned spacecraft and associated systems, for the selection and training of astronauts, and for operation of manned space flights. Mission Control for manned space flights, formerly at Cape Kennedy, now is based at the Manned Spacecraft Center.

The scientists and engineers who make up the technical staff of the Manned Spacecraft Center were responsible for placing the first American astronauts in space. Valuable experience gained in Project Mercury now is being utilized in Projects Gemini and Apollo.

GEORGE C. MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.

Launch vehicles essential to Apollo and other major space missions are designed and developed by the scientists and engineers of the Marshall Space Flight Center. Named for General George C. Marshall, the Center is presently concerned with launch vehicles of the Saturn class, as well as studying rendezvous operations, launch systems, feasibility, and other requirements.

Michoud Operations at Michoud, La. has been established to manufacture Saturn and other large launch vehicle stages.

The Mississippi Test Facility, located in a sparsely settled area about 50 miles east of New Orleans, is a facility for static tests of launch vehicles.

NUCLEAR ROCKET DEVELOPMENT STATION, JACKASS FLATS, NEV.

This facility, located at Jackass Flats, near Las Vegas, Nev., is managed by the Space Nuclear Propulsion Office, a joint operation of NASA and the Atomic Energy Commission. This major facility contains the laboratories, test stands and equipment for development of reactor technology and the nuclear engine and rocket stage for the nuclear rocket. The Station is the scene of many tests for the nuclear rocket program, which is in the advanced phases of research for missions to follow after the Apollo lunar landing project.

PACIFIC LAUNCH OPERATIONS OFFICE, LOMPOC, CALIF.

The NASA Pacific Launch Operations Office provides administrative, logistic, and technical support for NASA programs and projects at the Western Test Range.

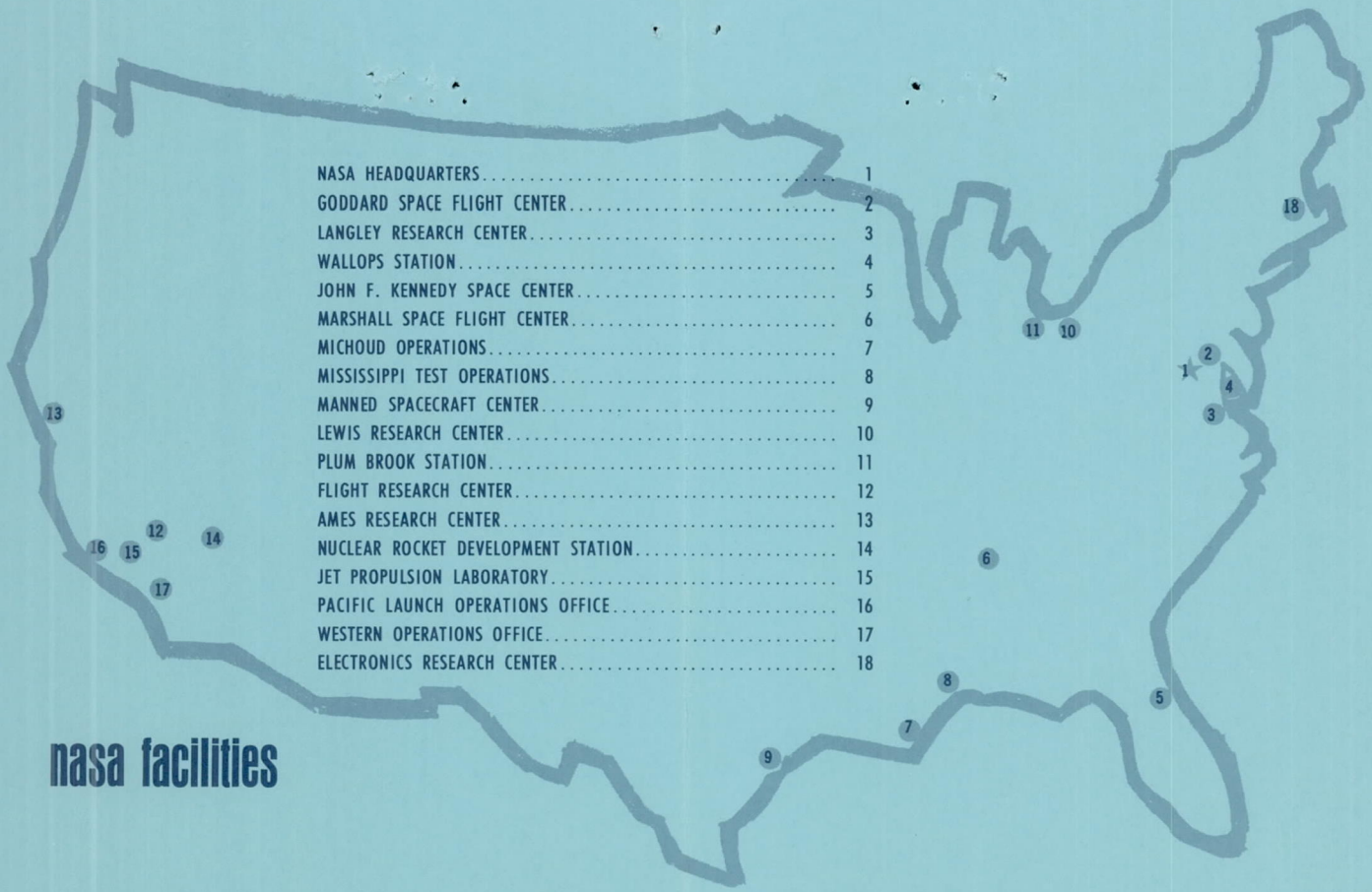
WALLOPS STATION, WALLOPS ISLAND, VA.

The rocket-borne experiments flown from the Wallops Island Range are conceived, designed and built, by scientists and engineers in laboratories and research centers throughout the U.S. and in many of the countries of the world. Functions of Wallops Station are payload checkout, vehicle preparation and launching, instrumentation and data acquisition, processing and reduction of data, and tracking of vehicles.

WESTERN OPERATIONS OFFICE, SANTA MONICA, CALIF.

The Western Operations Office is a branch of NASA Headquarters serving all operational interests of the agency in the Western states. Primary mission of the Office is contract negotiation and management of research and development contracts with Western aerospace industry.

ISSUED BY OFFICE OF PUBLIC AFFAIRS,
EDUCATIONAL PROGRAMS AND SERVICES OFFICE,
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546



nasa facilities

NASA HEADQUARTERS, WASHINGTON, D.C.

NASA Headquarters formulates policy and coordinates the activities of the space flight centers, research centers, and other installations which comprise the National Aeronautics and Space Administration.

AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.

The work of the Ames Research Center is concerned with laboratory and flight research in unmanned space flight projects and in aeronautics. The fields of interest include fundamental physics, materials, guidance and control, chemistry and life sciences. Ames aeronautical projects include the supersonic transport, V/STOL aircraft and operations research. The space flight projects involve management of scientific probes and satellites, and payloads for flight experiments.

ELECTRONICS RESEARCH CENTER, CAMBRIDGE, MASS.

This Center was established to stimulate research and advanced development in electronics and related fields for application in space and aeronautics. The Center organizes, sponsors and conducts programs in the basic disciplines of guidance, control, navigation, communications, data processing, electronic components, microwave and electromagnetic technology, and reliability.

FLIGHT RESEARCH CENTER, EDWARDS, CALIF.

The Flight Research Center is concerned with manned flight within and outside the atmosphere, including low-speed, supersonic, hypersonic and reentry flight, and air operations and safety problems. Major programs include aeronautics projects such as the X-15, supersonic transport and paraglider; space vehicle programs are typified by studies such as flight behavior of lifting bodies. In biotechnology, man-machine integration problems are studied.

GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.

The Goddard Space Flight Center, named for the rocket pioneer, Dr. Robert H. Goddard, is responsible for the development and management of a broad variety of unmanned earth-orbiting satellite and sounding rocket projects. Scientific, communications and meteorological satellites are included. (Orbiting Observatories, Explorers, TIROS, Nimbus, Relay, Syncom and others). Goddard also is the nerve center for the worldwide tracking and communications network for both manned and unmanned satellites.

JET PROPULSION LABORATORY, PASADENA, CALIF.

The Jet Propulsion Laboratory is operated under contract to NASA by the California Institute of Technology. Its primary missions are the devel-